

Practical ET estimation from Landsat

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SEB and H

When using the SEB-based algorithms to estimate ET we all want the same thing – H – so that we can calculate ET as a residual of the SEB equation

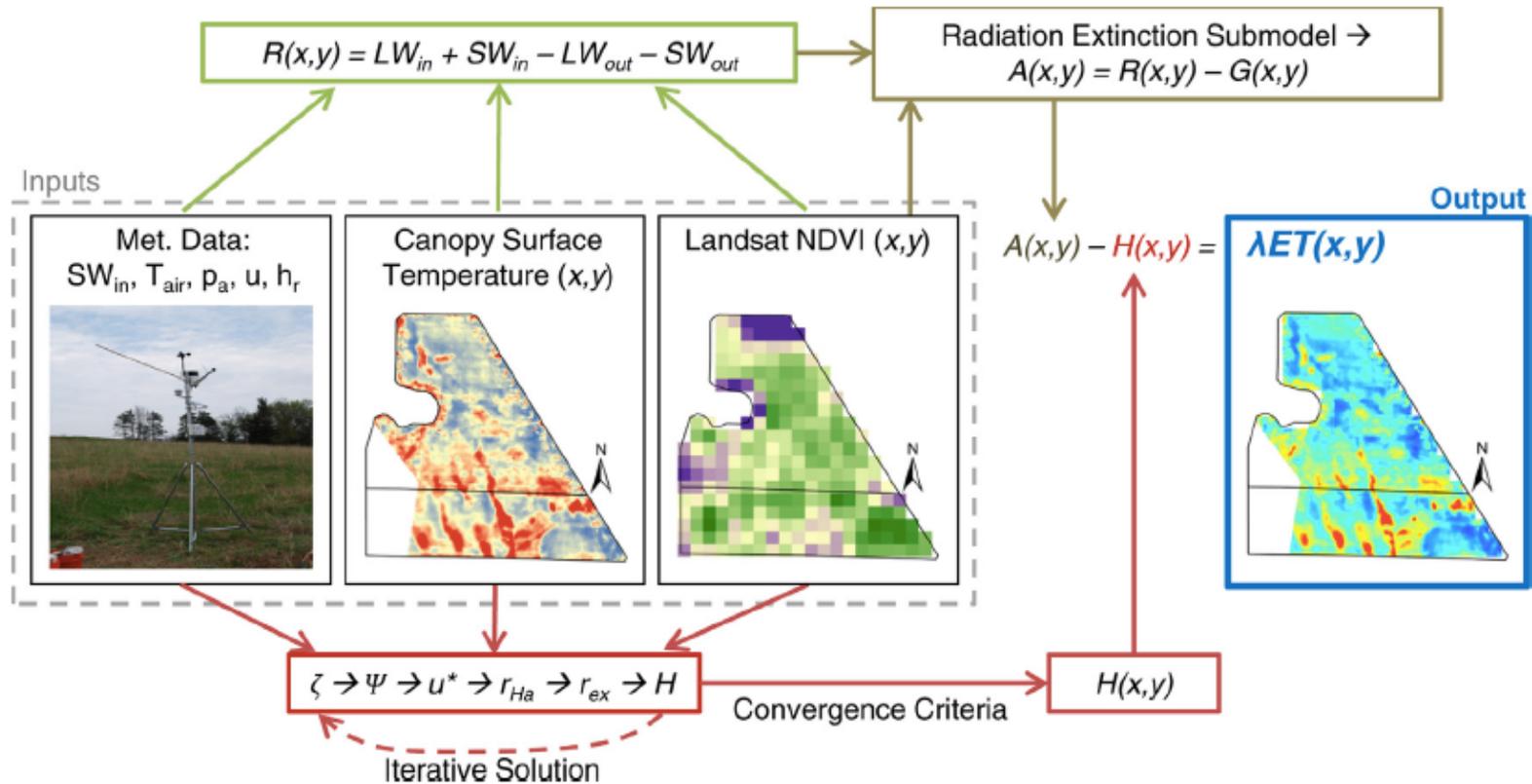
$$LE = RN - H - G$$

So it would be desirable to develop a practical approach to estimating H that is free of hot or cold pixels or more involved PBL-based approaches

Iterative solution to H

- Zipper and Loheide (2014) developed a practical model called High Resolution Mapping of EvapoTranspiration (HRMET)
- In HRMET there is an iterative solution to finding H (following Bastiaanssen et al 1998)
- Start with arbitrary values of input variables along with the H itself
- Assume known uncertainty probably distribution around each input and iterate until convergence
- The uncertainty at the solution is comparable to other SEB models
- Benefit: no need for “hot” and “cold” pixels or involved PBL estimation

HRMET



Conceptual diagram of the required model inputs for the HRMET energy balance model and interactions between necessary inputs. Each component of the energy balance requires the same inputs and the model solves for ET. Figure from Zipper and Lohiede (2014)

HRMET steps

- Calculate zero-plane displacement height, roughness lengths for momentum and heat transfer as a function of LAI and crop height (Raupach 1994)
- Set arbitrary initial values for H and M-O stability parameters
- Calculate diabatic correction factors for momentum and heat flux (Campbell and Norman 2000)
- Calculate friction velocity (Norman and Becker 1995)
- Calculate aerodynamic resistance (r_{Ha}) and excess resistance (r_{ex}) to heat transport
- Calculate a new value for H and related M-O stability factors
- Repeat these steps until convergence occurs

Repeat these steps for both positive and negative atmospheric stability
convergence on a global solution to H occur if values from both positive and negative
sets of initial conditions are within 0.1% of each other

Permutation based approach

- HRMET uses a permutation-based approach for calculating SEB that allows uncertainty in input variables to be calculated (Serbin et al., 2014)
- HRMET is solved 100 times at each point. Inputs are varied by selecting randomly from a standard normal distribution based on known (expected) mean and standard deviation for each variable
- This produces 100 ET estimates at each point using unique input parameters. These are then used to calculate a final mean and standard deviation of estimated ET for each pixel

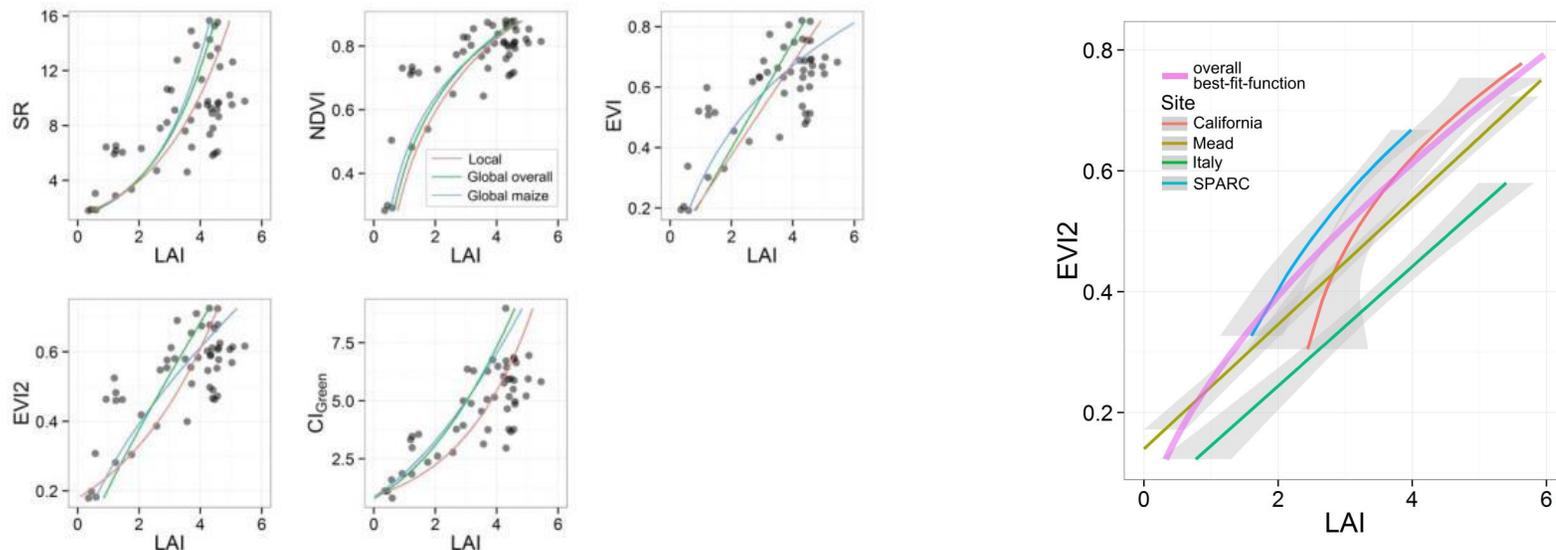
HRMET inputs

- 1) Site Specific
 - location (lat/lon), time etc.
- 2) Meteorological
 - Tair, SWrad, wind speed, Pressure, vapor pressure
- 3) Remote sensing
 - emissivity, albedo, LAI, crop height, Tsurf
(follows SEBAL/METRIC to calculate emis, alb etc.)

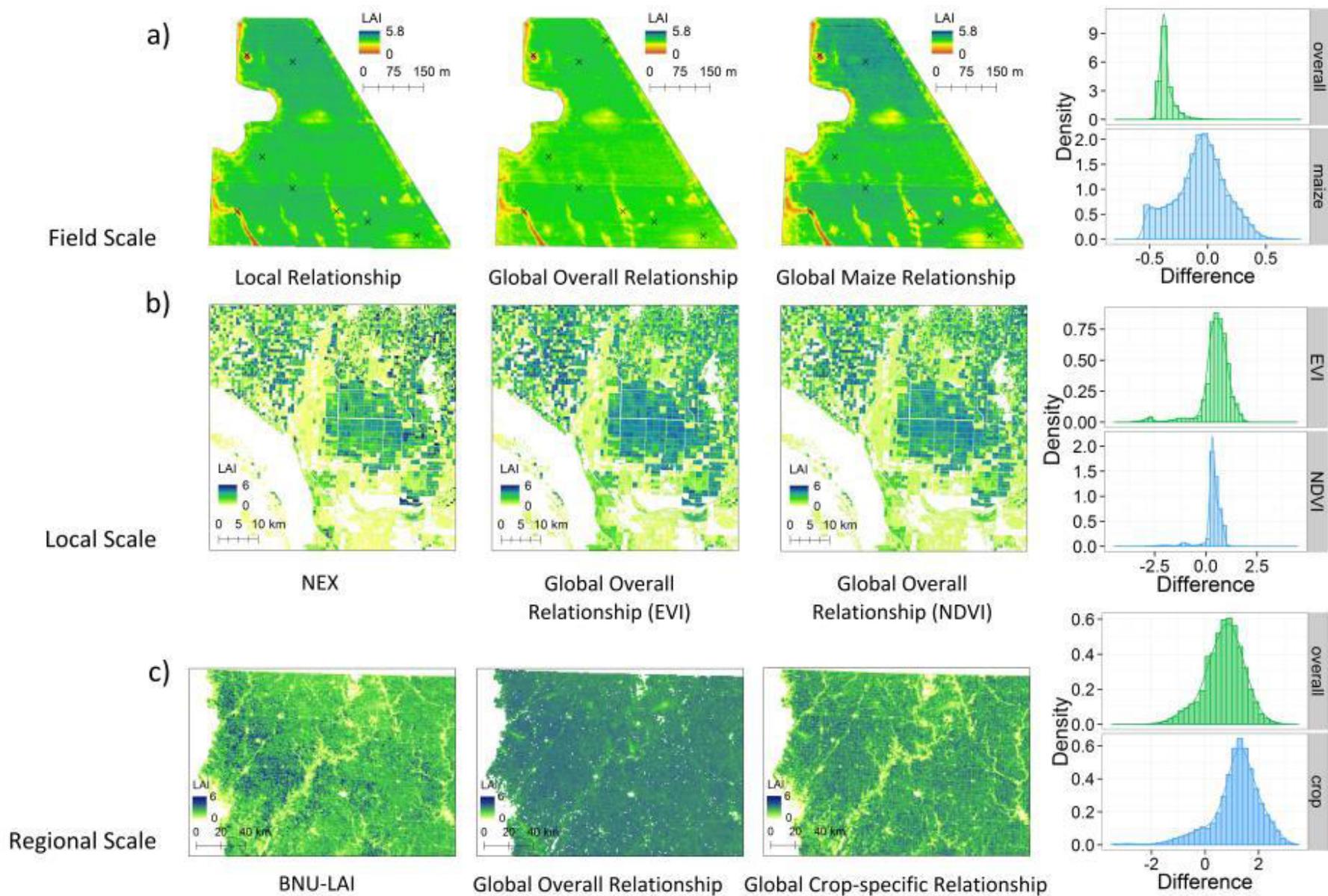
VI vs LAI

Use a VI-LAI relationship developed from a large number field LAI observations around the globe (Kang et al 2015)

Index	Equation	Coefficient			95% confidence interval			Reasonable VI range	
		a	b	c	a	b	c		
Overall	SR	$y = a \times \log(x+b) + c$	1.94	0.34	-0.91	(1.65,2.23)	(-0.36,1.04)	(-1.7,-0.12)	[1.21,32.21]
	NDVI	$y = a \times b^x$	0.26	26.28	-	(0.22,0.3)	(21.21,31.34)	-	[0,0.99]
	EVI	$y = a \times x + b$	5.67	-0.26	-	(5.39,5.95)	(-0.41,-0.11)	-	[0.04,1]
	EVI2	$y = a \times x^b$	6.21	1.16	-	(5.92,6.49)	(1.09,1.24)	-	[0,0.96]
	CI _{Green}	$y = a \times x^b + c$	2.86	0.42	-2.60	(1.45,4.28)	(0.28,0.55)	(-4.14,-1.06)	[0.76,17.17]



VI vs LAI



Application in Morocco

- We have applied the HRMET model to an irrigated perimeter in Morocco
- Weather data from an automated meteorological station funded by a WB-GEF project
- Fields cultivated with SugarBeet, Potatoes, cereals
- Several fields equipped with soil moisture and flux for water balance calculations

Projet LDAS, Février 2015

Secteur de Boulaouane : Occupation du sol 2013/2014

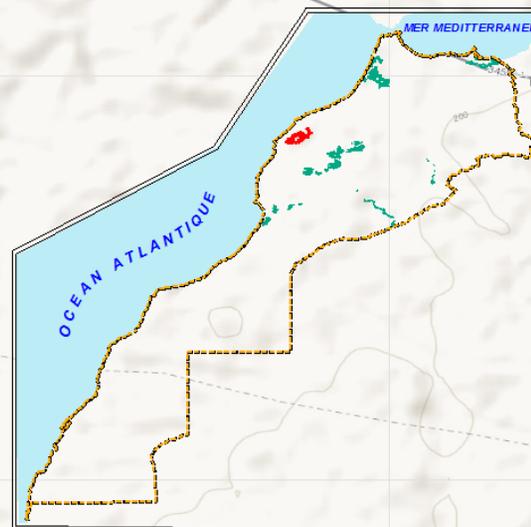
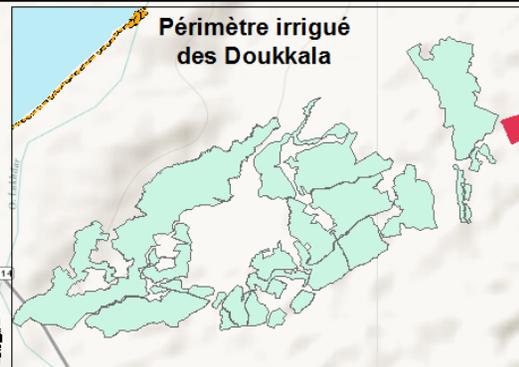
Echelle : 1/20 000



LEGENDE

-  Blocs d'irrigation
-  Turnip
-  Vine
-  Olive tree
-  Citrus
-  Onion
-  Pomgranate
-  Potato
-  Alfalfa
-  Weat
-  Broad bean
-  Sugar beet
-  Limites Boulaouane

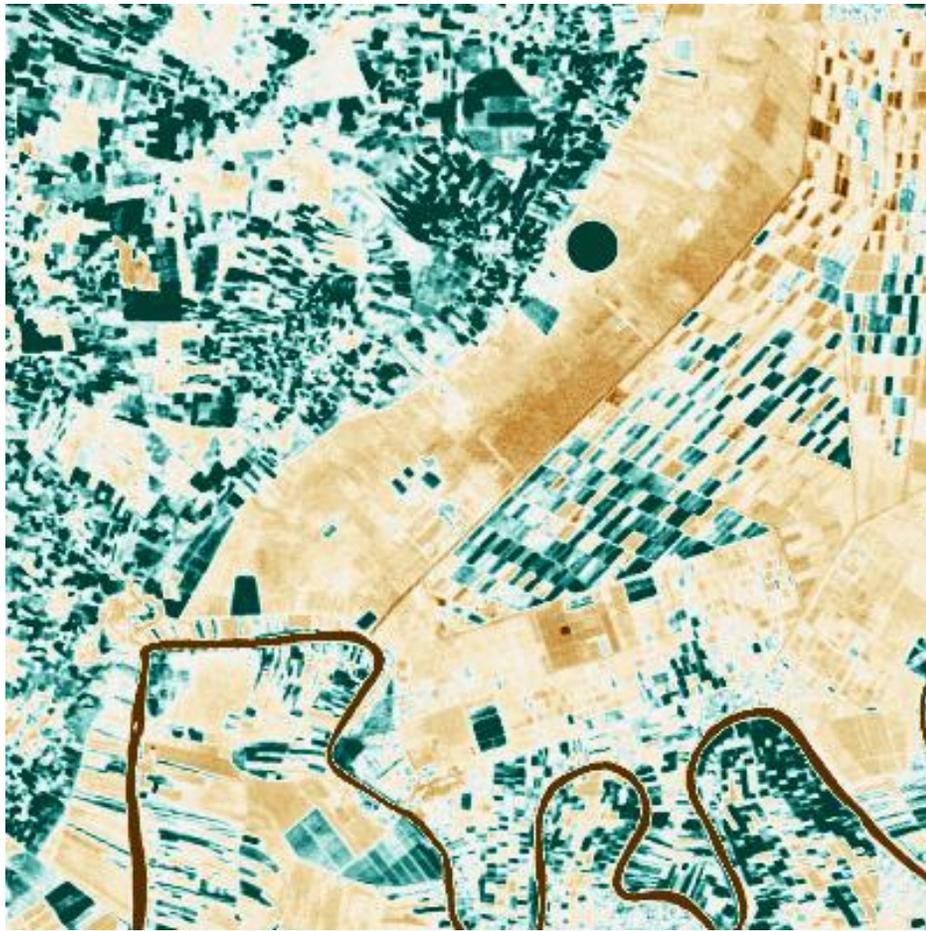
0 0.5 1 2 Km



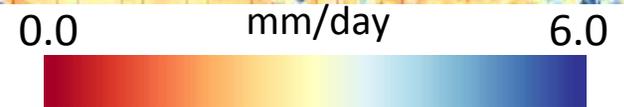
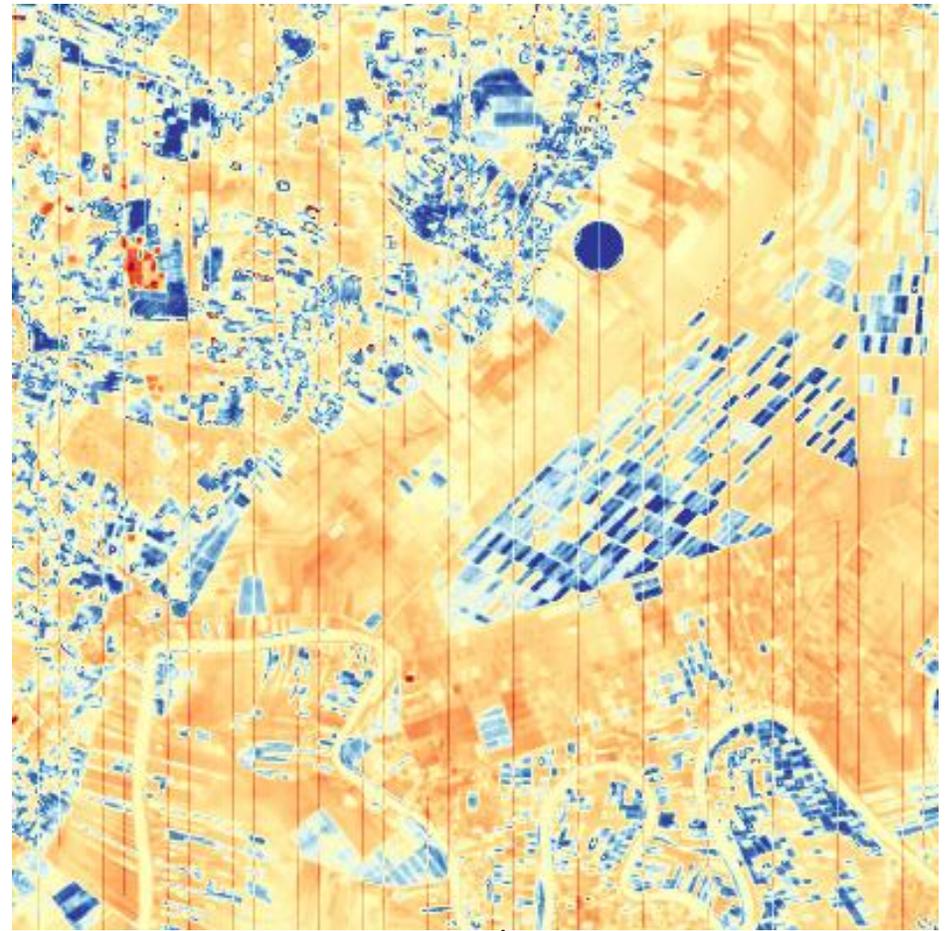


Example 1

NDVI



ET

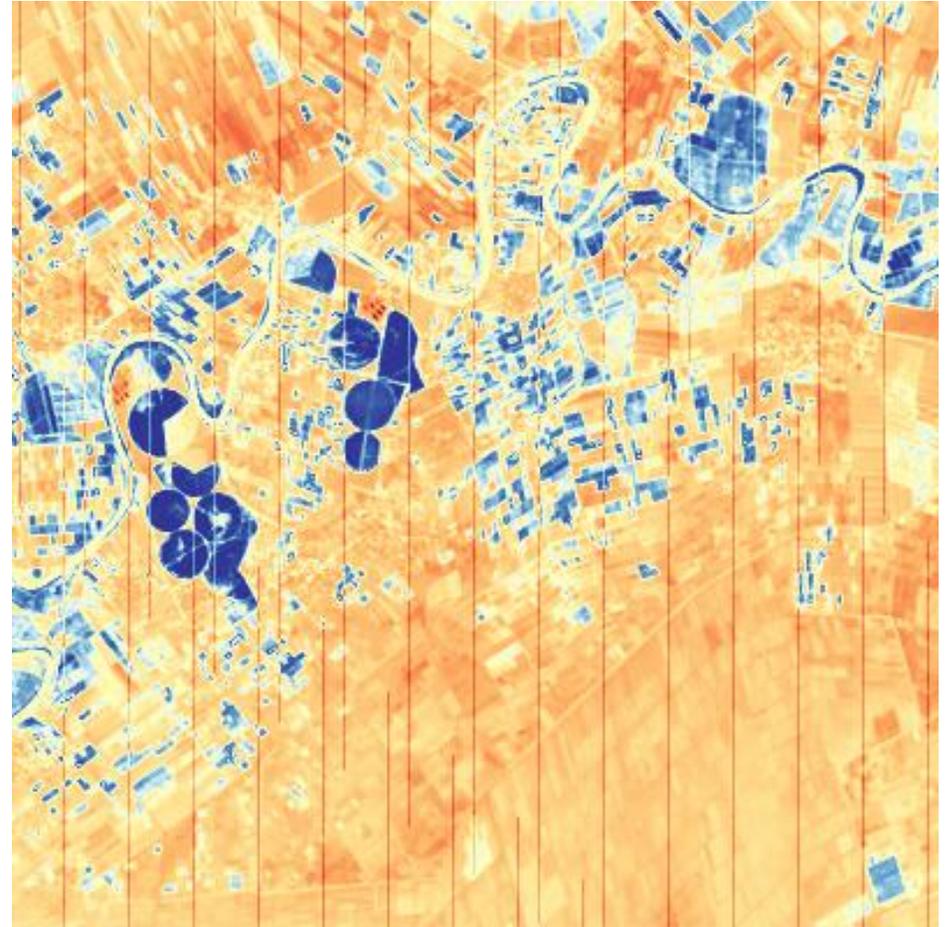


Example 2

NDVI



ET

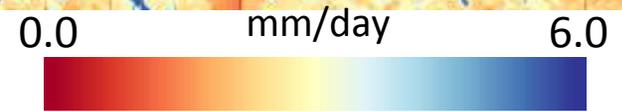
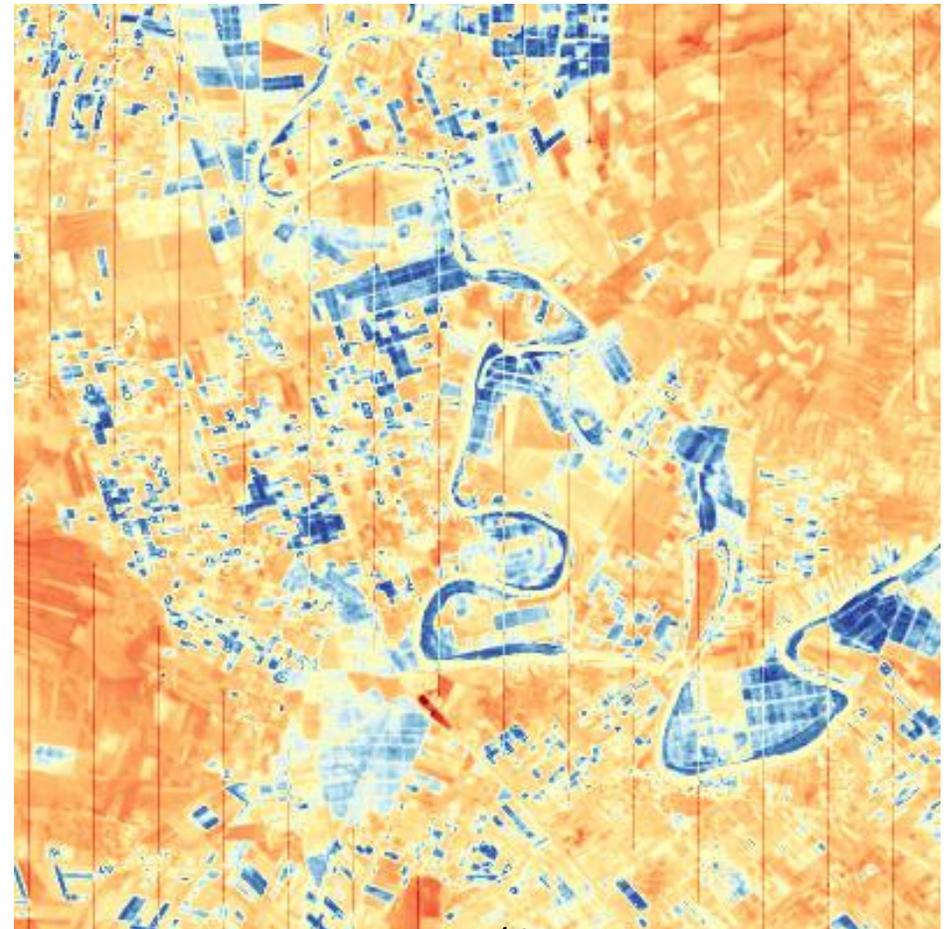


Example 3

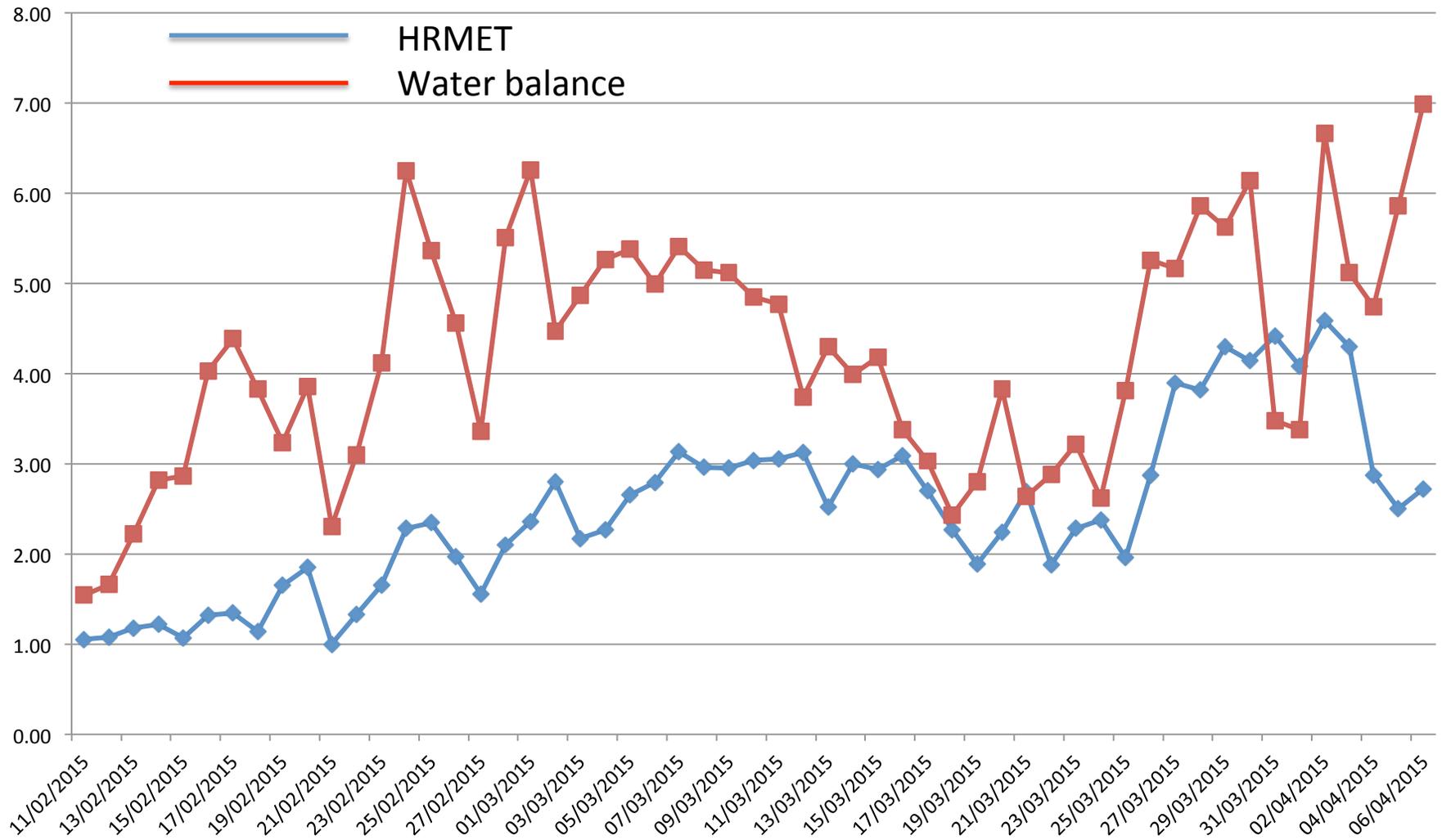
NDVI



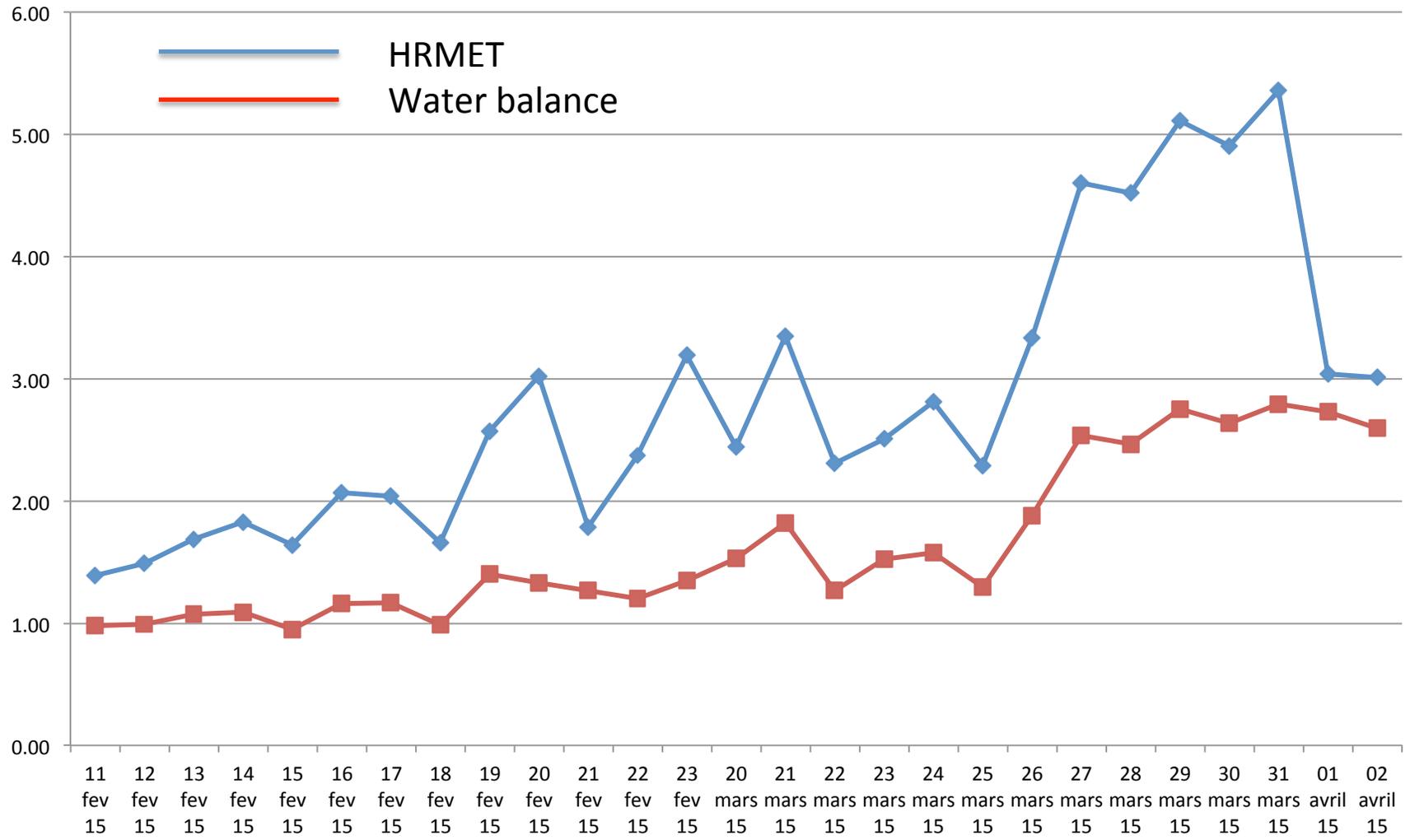
ET



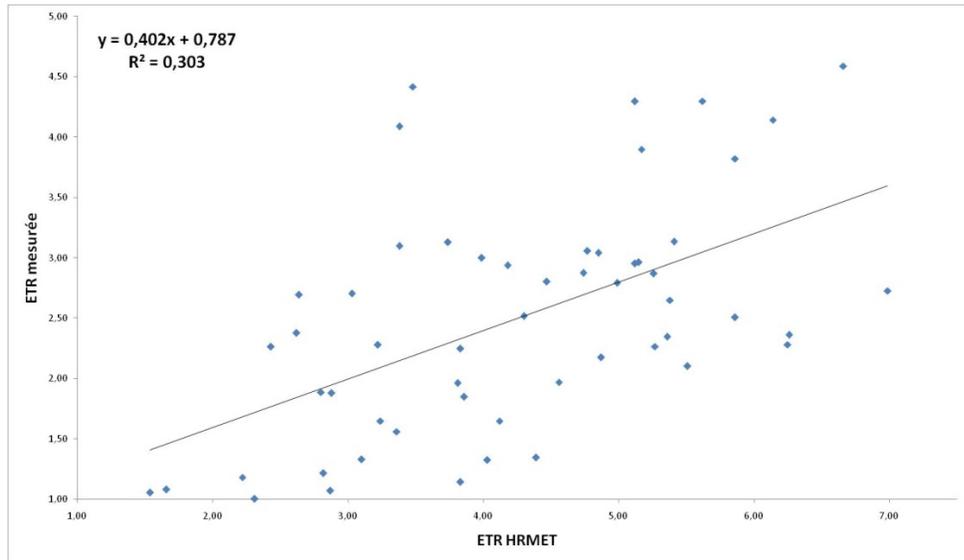
Field : Sugar beet (B1)



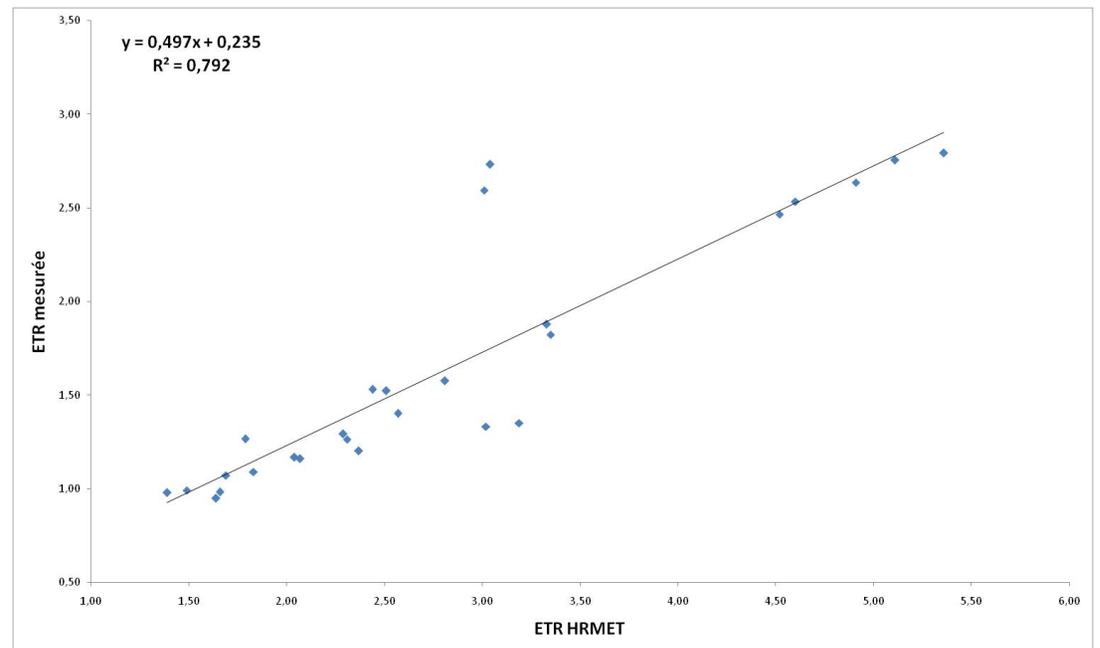
Field : Alfalfa (L1)



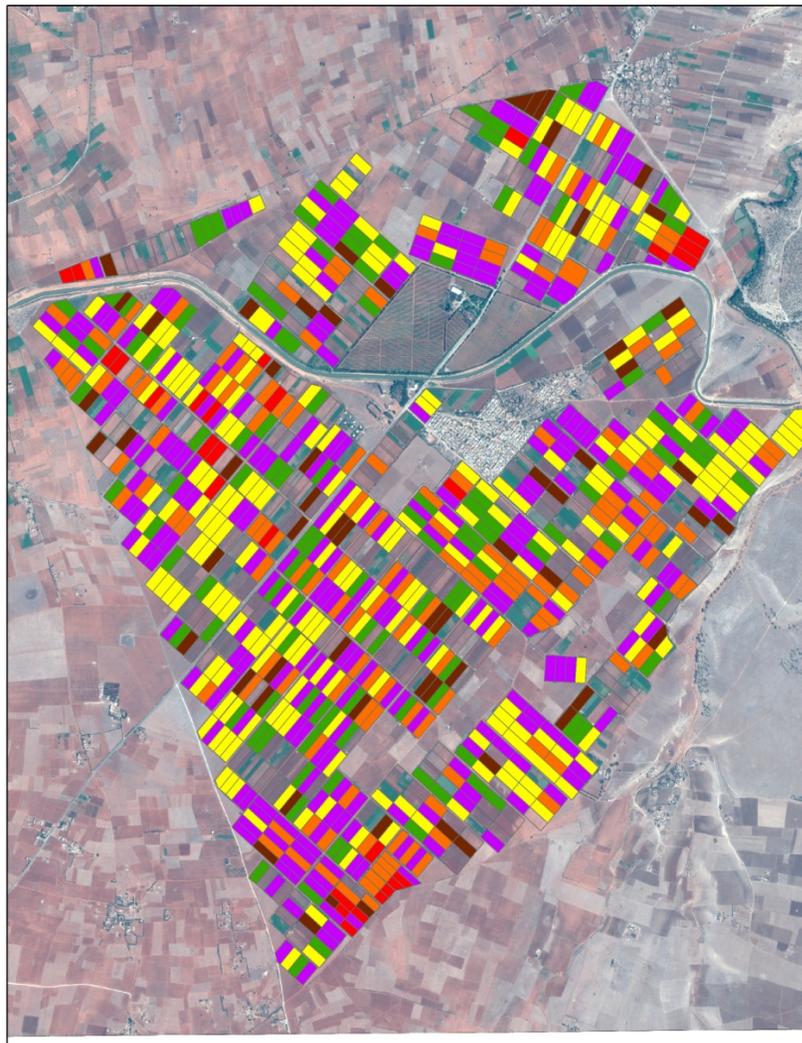
Field : Sugar Beet (B1)



Field : Alfalfa (L1)



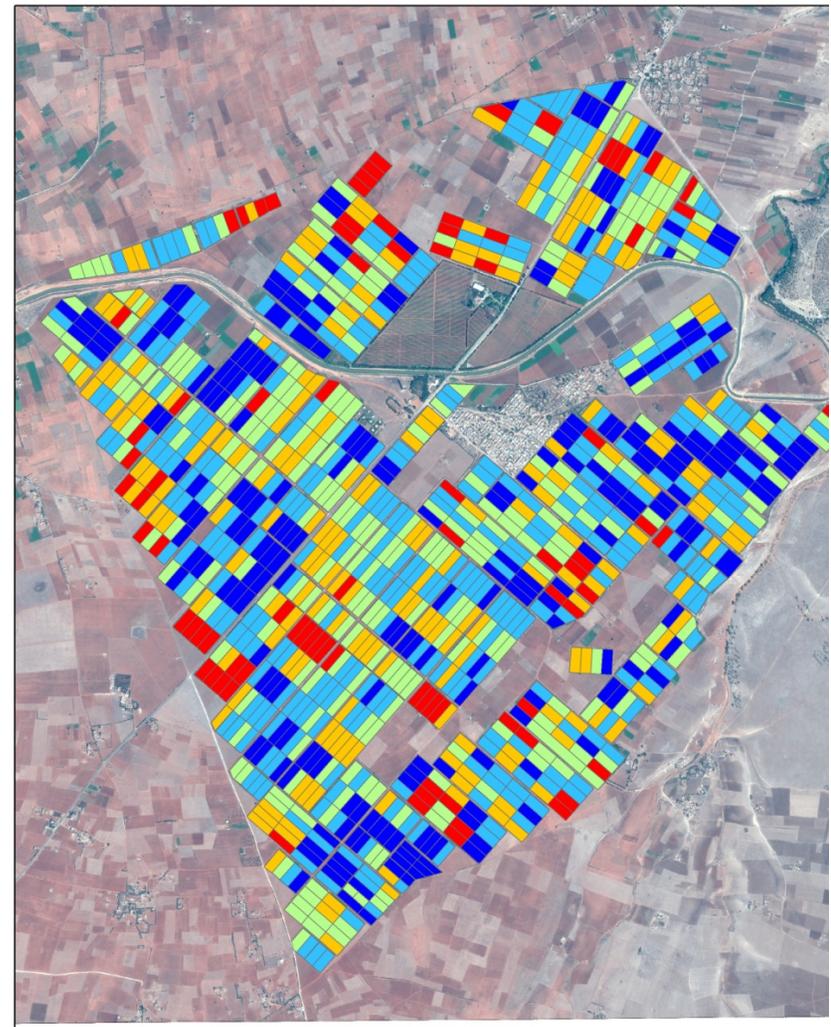
Cumulated ET (mm) from Jan 27 to Apr 17, 2015



Légende

14,91 - 28,66	38,96 - 45,05	51,51 - 60,57
28,67 - 38,95	45,05 - 51,50	60,58 - 73,01

Daily ET (mm) processing from Landsat image (25 August 2015)



Légende

0-1.5	1.5-3.0	3.0-4.5	4.5-6.0	> 6
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Thank you

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